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FOREIGN TECHNOLOGY DIVISION

THE THEORY OF METERS OF THE FIELD OF THE PULSATIONS OF THE REFRACTIVE INDEX IN SEA WATER

By

Ye. A. Agafonov, S. V. Dotsenko

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Block	Italic	Transliteration	Block	Italic	Transliteration
А а	*А а*	A, a	Р р	*Р р*	R, r
Б б	*Б б*	B, b	С с	*С с*	S, s
В в	*В в*	V, v	Т т	*Т т*	T, t
Г г	*Г г*	G, g	У у	*У у*	U, u
Д д	*Д д*	D, d	Ф ф	*Ф ф*	F, f
Е е	*Е е*	Ye, ye; E, e*	Х х	*Х х*	Kh, kh
Ж ж	*Ж ж*	Zh, zh	Ц ц	*Ц ц*	Ts, ts
З з	*З з*	Z, z	Ч ч	*Ч ч*	Ch, ch
И и	*И и*	I, i	Ш ш	*Ш ш*	Sh, sh
Й й	*Й й*	Y, y	Щ щ	*Щ щ*	Shch, shch
К к	*К к*	K, k	Ъ ъ	*Ъ ъ*	"
Л л	*Л л*	L, l	Ы ы	*Ы ы*	Y, y
М м	*М м*	M, m	Ь ь	*Ь ь*	'
Н н	*Н н*	N, n	Э э	*Э э*	E, e
О о	*О о*	O, o	Ю ю	*Ю ю*	Yu, yu
П п	*П п*	P, p	Я я	*Я я*	Ya, ya

*ye initially, after vowels, and after ъ, ь; e elsewhere.
When written as ё in Russian, transliterate as yё or ё.

RUSSIAN AND ENGLISH TRIGONOMETRIC FUNCTIONS

Russian	English	Russian	English	Russian	English
sin	sin	sh	sinh	arc sh	$sinh^{-1}$
cos	cos	ch	cosh	arc ch	$cosh^{-1}$
tg	tan	th	tanh	arc th	$tanh^{-1}$
ctg	cot	cth	coth	arc cth	$coth^{-1}$
sec	sec	sch	sech	arc sch	$sech^{-1}$
cosec	csc	csch	csch	arc csch	$csch^{-1}$

Russian	English
rot	curl
lg	log

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THE THEORY OF METERS OF THE FIELD OF THE PULSATIONS OF THE REFRACTIVE INDEX IN SEA WATER.

Ye. A. Agafonov, S. V. Dotsenko.

The theory of meters of pulsations of the light refraction coefficient in sea water is discussed. The influence of the geometric dimensions of an optical sensor on its bandpass of spatial scales of pulsations field non-uniformities of the refraction coefficient is studied. Distortions introduced by the optical sensor into the spectrum of theoretical models of fields, the most similar to those encountered in hydrophysical research are covered.

The obtained results permit the elucidation of distortions introduced by the optical sensor into supposed theoretical models of fields and more deliberate approach to the construction of optical sensors with the pre-set bandpass of spatial scales of the refraction coefficient.

For determining the small changes in the refractive index of transparent media, widely are applied the schlieren methods. They successfully are utilized during the study of the convection currents, shock waves, quality of optical glass, crystals of different minerals, etc. These methods can be also used for studying density fluctuations of sea water, which appear under the effect of turbulent processes in water layer [1].

The possibility of using the schlieren methods for studying the hydrophysical fields causes the need for the construction of the

theory of the work of the meters of the pulsations of the refractive index of world/light taking into account the specific character, which is inherent in the physical fields of the ocean.

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In this work is placed the task of the theoretical determination of the spectral range of the meters of the pulsations of the refractive index of sea water taking into account the three-dimensional/space averaging of density field, realized by their sensors, which is necessary for explaining the degree of distortions introduced by these sensors into the statistical characteristics of the fields being investigated. The structure of the theoretical models of the fields, with the aid of which is conducted the analysis of the work of instrument, is close to real, that is encountered in the practice of hydrophysical investigations.

Known there is many works on the theory of the measurement of transparent heterogeneities in connection with the tasks of gas dynamics, in which is utilized the assumption about the flat/plane or axisymmetric form of heterogeneities. Such models are not used for the study of the physical fields of the ocean whose structure differs significantly from those indicated idealized by heterogeneities because of the charge variation of these fields in time and space.

They here prove to be more corresponding to the reality of the model of the isotropic or locally isotropic fields which are examined below.

The schematic diagram of the meter of the pulsations of the refractivity gradient (Fig. 1) coincides with the classical schematic cf the schlieren-instrument. World/light from the source of light I is focused by lens L in the plane of point light diaphragm D. With the aid of objective O_1, is form/shaped the pencil beam, which through the exit of illuminator IL_1 enters into the volume of water being investigated IO. In passing by this volume, the luminous flux falls to input illuminator IL_2 and with the aid of objective O_2 is accumulated in the plane of the shadow diaphragm TD, after which is arrange/located the photoreceiver PF. If in water on the path of light rays there are nc refractivity gradients, then the source of the image cf count is completely overlapped by circular shadow diaphragm and to photoreceiver world/light does not fall. In the presence of gradients in the examine/scanned volume, the light rays are deflect/diverted and are recorded by light receptor.

Figure 2 gives the possible form of schlieren photograph. The random character of a change in the density field determines and the random character of a change in the configuration of light five-and, the displacement/movements of its "center of gravity" of 0, value of

its area and distribution of illumination within the limits of spot. The study of the statistical characteristics of any of the named values makes it possible to investigate the connected with them statistical characteristics of density field.

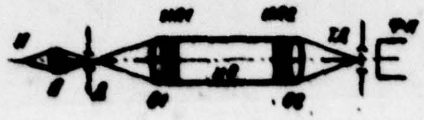

Fig. 1. Schematic of a schlieren instrument.

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We investigate communication/connection of the statistical characteristics of the "center of gravity" of spot with the statistical characteristics of field. For this first let us find communication/connection of the angle of deflection α of elementary light ray from the axis of device with form by passable by it optical heterogeneity.

It is known [for 2] that the coordinates of light ray at point z after its passage through the optically inhomogeneous medium are determined by the equations

$$\left.\begin{aligned} x'' &= (1+x'^2+y'^2)\left[\frac{\partial}{\partial x}\ln n(x,y,z) - x'\frac{\partial}{\partial z}\ln n(x,y,z)\right] \\ y'' &= (1+x'^2+y'^2)\left[\frac{\partial}{\partial y}\ln n(x,y,z) - y'\frac{\partial}{\partial z}\ln n(x,y,z)\right] \end{aligned}\right\} \quad (1),$$

where $n(x,y,z)$ - a refractive index of medium, while x and y - coordinates of position of light ray on plane, perpendicular to the optical axis of device, which is located at a distance z from exit of the illuminator (Fig. 8). By prime is marked differentiation with

respect to coordinate

Let us introduce the substitution

$$n(x,y,z) = n_0 \left[1 + \frac{n_{\phi}(x,y,z)}{n_0}\right], \quad (2)$$

where n_0 - constant component of refractive index; $n_{\phi}(x,y,z)$ its fluctuation component Furthermore, let us designate

$$\frac{n_{\phi}(x,y,z)}{n_0} = \gamma f(x,y,z), \quad (3)$$

where $f(x,y,z)$ - spatial distribution of refractive index, calibrated in such a way that

$$|f(x,y,z)|_{max} = 1,$$

while value γ characterizes by itself the intensity of fluctuations.

From the formula of Lorentz-Lorentz [3], that connects density ρ and refractive index of medium n, follows

$$\frac{n^2-1}{n^2+2} = k\rho, \quad (4)$$

where k - a constant. Differentiating (4) and transfer/converting to finite increments we will obtain

$$\Delta n = \frac{(n^2-1)(n^2+2)}{6n} \cdot \frac{\Delta\rho}{\rho}.$$

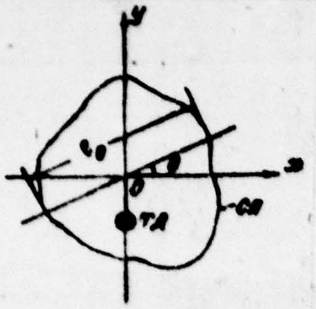

Fig. 2.

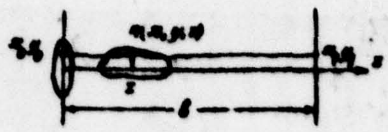

Fig. 3.

Fig. 2. Schlieren image; SP - light spot; TD - shadow diaphragm.

Fig. 3. Passage of elementary light ray through optical heterogeneity.

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Calculation on the obtained formula of the probable deviations of the refractive index of water on the basis of the available these fluctuations of the density of sea water, caused by the fluctuations of temperature and salinity, shows that $\gamma_{max} < 10^{-2}$. It is possible to count in actuality which $\gamma < 10^{-3}$, since the local jump/drops in the salinity and temperature, which correspond γ_{max}, in nature exists. Combining expressions (2) and (3), we will obtain

$$n(x,y,z) = n_0[1+\gamma f(x,y,z)].$$

In view of the smallness of fluctuations, it is possible to count

$$\ln n(x,y,z) = \ln n_0 + \gamma f(x,y,z).$$

The substitution of the obtained relationship/ratio into system (1), solution of this system by the expansion of entering it equations according to the degrees of the small parameter γ and disregard of the terms, which contain γ to degree is higher than the first, it gives

$$\left.\begin{aligned} \xi^{0}(z) &= \gamma \frac{\partial}{\partial x_0} f(x_0, y_0, z), \\ \eta^{0}(z) &= \gamma \frac{\partial}{\partial y_0} f(x_0, y_0, z), \end{aligned}\right\} \quad (8)$$

where $\xi(z)$ and $\eta(z)$ - angles of deflection of ray/beam from freference coordinates along the aces Ox and Oy, at distance z from the output illuminator. The beam's angle of slope to the ames Ox and Oy, at which it enters the window of the input illuminator, arrange/located at a distance l from exit illuminator, under the condition of their smallness accordingly (5) they are equal to

$$\left.\begin{aligned} \varepsilon_x &= \gamma \int_0^l \frac{\partial}{\partial x_0} f(x_0, y_0, z)\,dz, \\ \varepsilon_y &= \gamma \int_0^l \frac{\partial}{\partial y_0} f(x_0, y_0, z)\,dz. \end{aligned}\right\} \quad (9)$$

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The obtained relationship/ratios give unknown communication/connection of the projections of angle of deflection ε_x and ε_y of elementary light ray from the optical axis of device on its input illuminator with the form of the optical heterogeneity, placed in function f(x, y, z).

Since the heterogeneities of the refractive index of sea water are movable and chactic, subsequently we consider that the distribution of fluctuaticns in space has randcm character, i.e., function $f(x,y,z)=f(\vec{r})$ is randcm and, generally speaking, it depends on time. Under the assumption cf uniformity and isotropy of the field cf the refractive index and applicability of the hypothesis of "frozen turbulence" the autccorrelaticn functicn B(f) of field f depends cnly en the modulus of three-dimensional/space shear between twc points of field, i.e.,

$$B_f(\vec{r}_2,\vec{r}_1)=B_f(\vec{r}_2-\vec{r}_1)=B_f(|\vec{r}_2-\vec{r}_1|)=$$
$$=B_f\left[\sqrt{(x_2-x_1)^2+(y_2-y_1)^2+(z_2-z_1)^2}\right].$$

Further let us consider these assumpticns carried out.

Let the instrument move relative to medium with a constant velocity of $\vec{v}_0$, and the axis cf its perpendicular to direction of moticn. In this case, the ccordinates of function f(x, y, z) change in time according to the law

$$\begin{aligned} x&=x_H+v_0t\cos\varphi, \\ y&=y_H+v_0t\sin\varphi, \end{aligned} \qquad (7)$$

where x_H and y_H - coordinates of the optical axis of device of the relatively stationary field of refractive index at the moment of time t=0, and φ - the angle, which composes velocity vector with the selected axis Ox. The dependence of the angles of deflection of ray/beam from time, accordingly (6) and (7), in this case takes the

form

$$\left.\begin{aligned} e_x(t) &= \gamma\int_0^l \frac{\partial}{\partial x_H} f(x_H + v_0 t\cos\varphi,\ y_H + v_0 t\tan\varphi,\ z)\,dz, \\ e_y(t) &= \gamma\int_0^l \frac{\partial}{\partial y_H} f(x_H + v_0 t\cos\varphi,\ y_H + v_0 t\sin\varphi,\ z)\,dz. \end{aligned}\right\} \quad (8)$$

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For a reduction in the recording during further calculations, let us designate

$$f_m(t,z) = f(x_m + v_0 t\cos\varphi,\ y_m + v_0 t\tan\varphi,\ z). \quad (9)$$

In the real instrument through the field being investigated it passes not elementary light ray, but luminous flux, which has final cross section. Let us deccmpose this flow on elementary light rays and let us examine the result of the combined action of the system of ray/beams. The deflected part of this flow after input illuminator, not delayed by shadow diaphragm, it is shown on Fig. 4. Let us consider that the intensity of elementary ray/beams upon their entrance into the medium being investigated is identical, and absorption and dissipation of their energy in medium is absent. Then the intensity of these ray/beams after shadow diaphragm is also identical, but, nevertheless, direct-shadow image can be substantially hetercgeneous, since on any elementary area/site it can hit different number of elementary ray/beams.

Consequently, the "center of gravity" of the luminous flux after

shadow diaphragm at the given instant has an angle of deflection from the optical axis of device along the axis Ox, given by the averaging of angle $\varepsilon_x(t)$ with respect to entire ensemble of the elementary light rays (averaging over the set of ray/beams let us designate by brackets < >):

$$\langle \varepsilon_x(t) \rangle = \frac{1}{S_{bx}} \int_{S_{bx}} \varepsilon_x(t)\, ds, \qquad (10)$$

where the integration is conducted over the surface of the input illusirator cf instrument. Divergence along the axis Oy is located analogously. Is hence time average the position of the "center of gravity" of the flow (average over time let us designate by the feature abcve the averaged function):

$$\overline{\langle \varepsilon_x(t) \rangle} = \frac{1}{S_{bx}} \int_{S_{bx}} \overline{\varepsilon_x(t)}\, ds = 0.$$

Taking into account expression (8) and assuming the absence of the constant field gradients of refractive index the standard deviation of the "center of gravity" from axis Ox at the fixed/recorded moment of time we will obtain

$$\varepsilon^2_{cp\,x}(t) = \langle \varepsilon_x(t) \rangle^2.$$

Fig. 4. The luminous flux after shadow diaphragm.

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Substitution into formula (10) of first relationship/ratio (8) taking into account designation (9) gives

$$<e_x(t)> = \frac{\gamma}{S_{\text{вых}}} \int_{S_{\text{вых}}} \int_0^l \frac{\partial}{\partial x_1} f_1(t, z_1)\, dz_1\, ds_1 . \qquad (11)$$

After squaring of expression (11) we will obtain

$$<e_x(t)^2> = \frac{\gamma^2}{S^2_{\text{вых}}} \int_{S_{\text{вых}}} \int_{S_{\text{вых}}} \int_0^l \int_0^l \frac{\partial}{\partial x_1} \cdot \frac{\partial}{\partial x_2} [f_1(t, z_1) f_2(t, z_2)]\, dz_1\, dz_2\, ds_1\, ds_2 . \qquad (12)$$

Is averaged the standard deviation of the "center of gravity" of the luminous flux during the infinite period of the time

$$e^2_{\text{ср}x} = \overline{e^2_{\text{ср}x}(t)} = \overline{<e_x(t)>^2}.$$

This value can serve as the characteristic of the size/dimensions of the luminescent spot on photoreceiver. As it follows from expression (12), for its determination it is necessary to define

$$\overline{f_1(t, z_1) f_2(t, z_2)} = \overline{f(x_1 + v_0 t\cos\varphi,\, y_1 + v_0 t\sin\varphi,\, z_1) f(x_2 + v_0 t\cos\varphi,\, y_2 + v_0 t\sin\varphi,\, z_2)},$$

while this expression is the correlation function of field, which, as noted above, in our case it depends only on the difference of the arguments of function f, i.e., has the form

$$B_f(x_2 - x_1,\, y_2 - y_1,\, z_2 - z_1).$$

Therefore

$$\varepsilon^2_{\varphi x} = \frac{\Gamma^2}{S^2_{bux}} \int_{S_{bux}} \int_{S_{bux}} \int_0^l \int_0^l \frac{\partial}{\partial x_1} \cdot \frac{\partial}{\partial x_2} B_f(x_2 - x_1, y_2 - y_1, z_2 - z_1)\, dz_1 dz_2 ds_1 ds_2 . \quad (18)$$

Let us note that the obtained value $\varepsilon_{\varphi x}$ does not depend on value and direction of the speed of the motion of instrument, i.e., the averaged for prolonged time interval schlieren image, obtained in the isotropic "frozen" field, must be circumference independent of speed and direction of the motion of instrument in field. The difference for this image from circumference must speak about the absence of the isotropy of field in the point of its measurement.

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As is known, the correlation function of uniform stray field $B_f(\vec{r})$ is connected with its three-dimensional spectrum by relationship/ratio [4]

$$B_f(x, y, z) = \iiint_{-\infty}^{\infty} e^{j(\alpha_1 x + \alpha_2 y + \alpha_3 z)} \cdot G(\alpha_1, \alpha_2, \alpha_3)\, d\alpha_1 d\alpha_2 d\alpha_3 ,$$

substitution of which into formula (13) gives

$$\varepsilon^2_{\varphi x} = \frac{\Gamma^2}{S_{bux}} \int_{S_{bux}} \left\{ \int_0^l \int_0^l \left[\iiint_{-\infty}^{\infty} \alpha_1^2 \frac{1}{S_{bux}} \int_{S_{bux}} e^{j[\alpha_1(x_2 - x_1) + \alpha_2(y_2 - y_1)]} \times \right.\right.$$

$$\left.\left. \times\, dS_2\, e^{j\alpha_3(z_2 - z_1)} \cdot G(\alpha_1, \alpha_2, \alpha_3)\, d\alpha_1 d\alpha_2 d\alpha_3 \right] dz_1 dz_2 \right\} dS_1 .$$

Taking into account the value of the integral

$$\int_0^l\int_0^l e^{j\alpha_3(z_2-z_1)}dz_1dz_2=l^2\left(\frac{\sin\frac{\alpha_3 l}{2}}{\frac{\alpha_3 l}{2}}\right)^2=l^2 Sa^2\left(\frac{\alpha_3 l}{2}\right),$$

it is simplified this expression

$$\varepsilon^2_{cpx}=\gamma^2 l^2\iiint_{-\infty}^{\infty}N(\alpha_1,\alpha_2)Sa^2\left(\frac{\alpha_3 l}{2}\right)G(\alpha_1,\alpha_2,\alpha_3)\alpha_1^2\,d\alpha_1\,d\alpha_2\,d\alpha_3, \qquad (14)$$

where markedly

$$N(\alpha_1,\alpha_2)=\frac{1}{S^2_{вых}}\int_{S_{вых}}\int_{S_{вых}} e^{j[\alpha_1(x_2-x_1)+\alpha_2(y_2-y_1)]}\,dS_1\,dS_2.$$

Last/latter value depends only on form and size/dimensions of the cross section of the luminous flux. If flow has section in the form of the circle of radius a, then $S_{вых}=\pi a^2$ and

$$N(\alpha_1,\alpha_2)=\Lambda_1^2\left(a\sqrt{\alpha_1^2+\alpha_2^2}\right).$$

In this case relationship/ratio (14) takes the form

$$\varepsilon^2_{cpx}=\gamma^2 l^2\iiint_{-\infty}^{\infty}\Lambda_1^2\left(a\sqrt{\alpha_1^2+\alpha_2^2}\right)Sa^2\left(\frac{\alpha_3 l}{2}\right)G(\alpha_1,\alpha_2,\alpha_3)\alpha_1^2\,d\alpha_1\,d\alpha_2\,d\alpha_3.$$

For further simplification in the obtained expression, let us note that the three-dimensional spectrum of isotropic field depends only on the module/modulus of wave number $G(\alpha_1,\alpha_2,\alpha_3)=G\left(\sqrt{\alpha_1^2+\alpha_2^2+\alpha_3^2}\right)$.

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After introducing in the space of wave numbers spherical coordinates, we will obtain

$$\varepsilon^2_{cpx}=\pi\gamma^2 l^2\int_0^{\infty}M(\alpha,a,l)G(\alpha)\alpha^2\,d\alpha, \qquad (15)$$

where

$$M(\alpha,a,l)=\alpha^2\int_0^{\pi}\left[\Lambda_1^2(\alpha a\sin\theta)\right]Sa^2\left(\frac{\alpha l}{2}\cos\theta\right)\sin^3\theta\,d\theta.$$

Transfer/converting in expression (15) to new variable $x = \alpha l$, we find

$$\varepsilon^2_{\varphi x} = \frac{\pi r^2}{l^3} \int_0^\infty M(x,\delta) G\left(\frac{x}{l}\right) x^2 dx, \qquad (16)$$

where the weighting function of expression (16)

$$M(x,\delta) = 2x^2 \int_0^{\pi/2} [\Lambda_1^2(x\delta \sin\theta)] Sa^2\left(\frac{x\cos\theta}{2}\right) \sin^3\theta \, d\theta, \qquad (17)$$

while $\delta = \frac{a}{l}$ is ratio of a radius of light beam to its length.

Let us note that weighting function $M(x,\delta)$ is determined by the configuration of the luminous flux and reflects the properties of differentiation of field by sensor and its three-dimensional/space averaging. The form of this function is laid in the construction/design of instrument and does not depend on the structure of the measured field.

Into formula (16) enters the three-dimensional spectrum of field $G(\alpha)$. More natural is its replacement by the one-dimensional spectrum of field $G_1(\alpha)$. This spectrum is measured by driving/moving in field point sensor [5]. Utilizing communication/connection of these two spectra [4]

$$G(\alpha) = -\frac{1}{2\pi\alpha} \cdot \frac{dG_1(\alpha)}{d\alpha},$$

from expression (16) we will obtain

$$\varepsilon^2_{\varphi x} = -\frac{r^2}{2l} \int_0^\infty M(x,\delta) \cdot \frac{dG_1\left(\frac{x}{l}\right)}{dx} x dx. \qquad (18)$$

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An especially simple form accepts the obtained expression if the

spectrum is described by the exponential function

$$G_1(\alpha) = C\alpha^{-\nu}. \quad (18)$$

In particular, the widely known "law of five thirds" is obtained hence with $\nu = 5/3$. Taking into account formula (19) we obtain

$$\varepsilon^2_{cp\,x} = \frac{l^2\nu}{2l}\int_0^\infty M(x,\delta)G_1\left(\frac{x}{l}\right)dx = C\frac{l^2\nu l^{\nu-1}}{2}\int_0^\infty M(x,\delta)x^{-\nu}dx. \quad (20)$$

Thus, the average standard deviation of the "center of gravity" of the luminous flux is proportional in our case to integral of the product of the weighting function of instrument $M(x, \delta)$ to the one-dimensional spectrum of field $G_1\left(\frac{x}{l}\right)$.

The family of the weighting functions, calculated for different ones δ with the aid of numerical integration for formula (17), is given in Fig. 5.

Since the weighting functions have clear expressed maximums, it is clear that the different regions of the spectrum make different contribution to ε^2_{cp}. Most essential proves to be that part of the spectrum of field, which is included in the band between $x_{мин}$ and $x_{макс}$, corresponding to half from the maximum value of weighting function $M(x, \delta)$.

It is possible to count, as is customary in radio engineering, that within the limits of band $x_{мин} < x < x_{макс}$ weighting function $M(x, \delta)$ (i.e. the transmission factor of the spectrum $G_1\left(\frac{x}{l}\right)$) is constant.

Consequently, in this band the value of the spectrum of the output signal of instrument is proportional to the value of the one-dimensional spectrum of the field of refractive index $G_1(\frac{x}{l})$. When $x<x_{min}$ function M(x, 6) behaves as the frequency characteristic of the filter of high frequency, and here the spectrum of the output signal of instrument is proportional to the spectrum of the field gradient of refractive index. This special feature/peculiarity of instrument is connected with its differentiating properties.

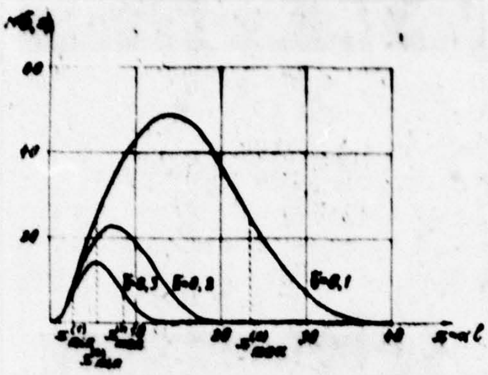

Fig. 5. Family of the weighting functions of optical sensor.

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In region $x > x_{макс}$ function $M(x, \delta)$ corresponds to the frequency characteristic of the filter of the low frequency, determined by the property of the three-dimensional/space averaging of field by instrument. The resulting curve is the frequency characteristic of band-pass filter whose parameters are wholly determined by the relationship/ratio of the size/dimensions of the sensor of instrument and can be previously taken into account in its construction/design.

As is evident in Fig. 5, the bandwidth of sensor strongly depends on δ. Thus, for instance, passband of the instrument, which has δ=0.1, exceeds by a factor of   the passband of the instrument, which has δ=0.3. Is characteristic also an increase in values of $M(x,$

6) during decrease δ.

Since in our case optical sensor is intended for obtaining the statistical characteristics of the field being investigated, then for obtaining the perfect information about these characteristics it is necessary to know the distortions which are introduced by sensor into the structure of the theoretical models of the fields, close to real, that are encountered in the practice of hydrophysical investigations. This structure is laid in $C\cdot\alpha^{-\nu}$

For explaining the distortions, introduced by sensor into the spectrum being investigated, was constructed the performance characteristics of integrand (20) - $M(x,\delta)x^{-\nu}$ for the "law of five thirds" with different ones δ (Fig. 6). Such curve/graphs have analogous character, also, for laws ν = 3/3, 4/3 and 6/3.

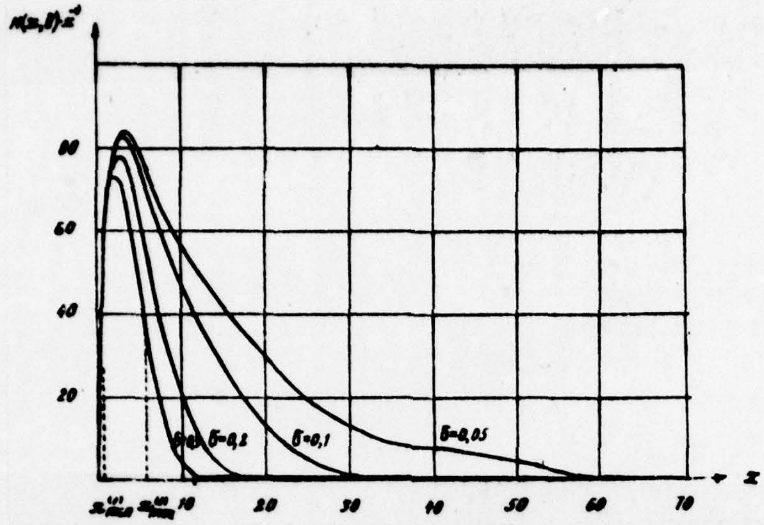

Fig. 6. Dependences $M(x,\delta)\cdot x^{-\nu}$

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In Fig. 6 to simply determine the band of the three-dimensional/space scales, which contribute the significant contribution to the output signal of optical sensor for different spectra of the field being investigated. Spectral component of the measured field, which lie out of this band, do not virtually affect the output sensor signal.

Analyzing the work of the meters of the pulsations of the refractive index of sea water, it is possible to note that the decrease of the diameter of light beam expands the passband of the three-dimensional/space scales, reproducible by optical sensor

without distortions. With the decrease of diameter, more vividly are exhibited the differentiating properties of sensor. Narrow light beam makes it possible to solve the small/finer optical heterogeneities, entering the structure of the field being investigated, decreasing the effect of averaging according to the diameter of the luminous flux. It is possible to count that in the region of low frequencies on section curved $M(x,\delta)x^{-\nu}$ from axis Ox to level 0.5 from maximum value the sensor possesses the differentiating properties. In the region of the passband of optical sensor, it evenly reproduces changes of the refractive index of world/light in the medium being investigated. On the descending high-frequency section of curve in the region of minimum three-dimensional/space scales, the sensor exhibits the integrating properties, which consist in the averaging of small/fine three-dimensional/space scales along the length of the basis of instrument.

Thus, is establish/installed communication/connection of the output sensor signal with the structure of fields, most frequently encountered in practice hydrophysical experiments, which makes it possible to explain the distortions, introduced by sensor into the field being investigated, and to compose the representation of boundaries of the applicability of sensor during the study of the field of refractive index.

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